Effectiveness Metrics and Cost Benefit Analysis Methodology for Machine-to-Machine Interoperability Standards

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NPS

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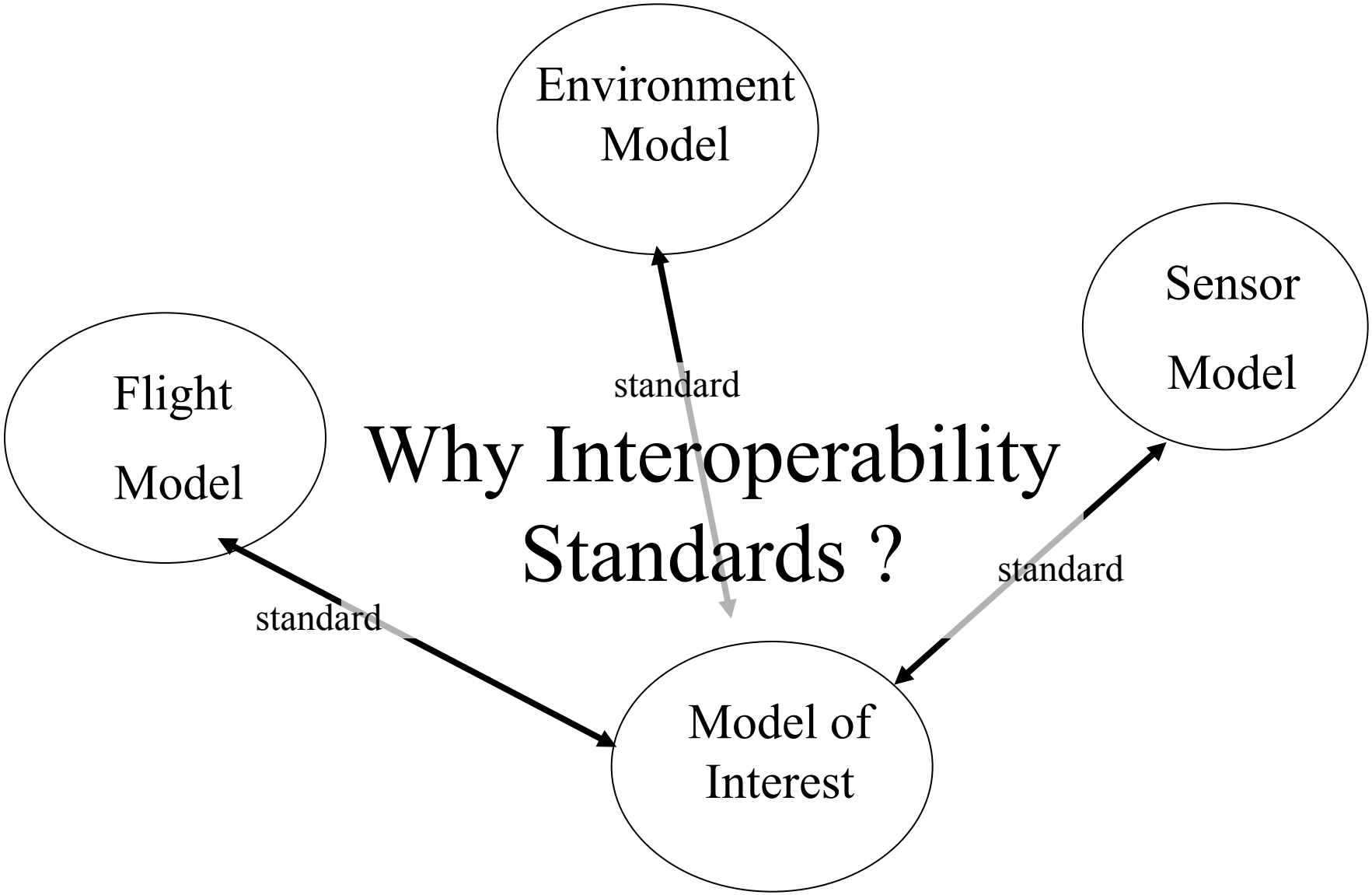


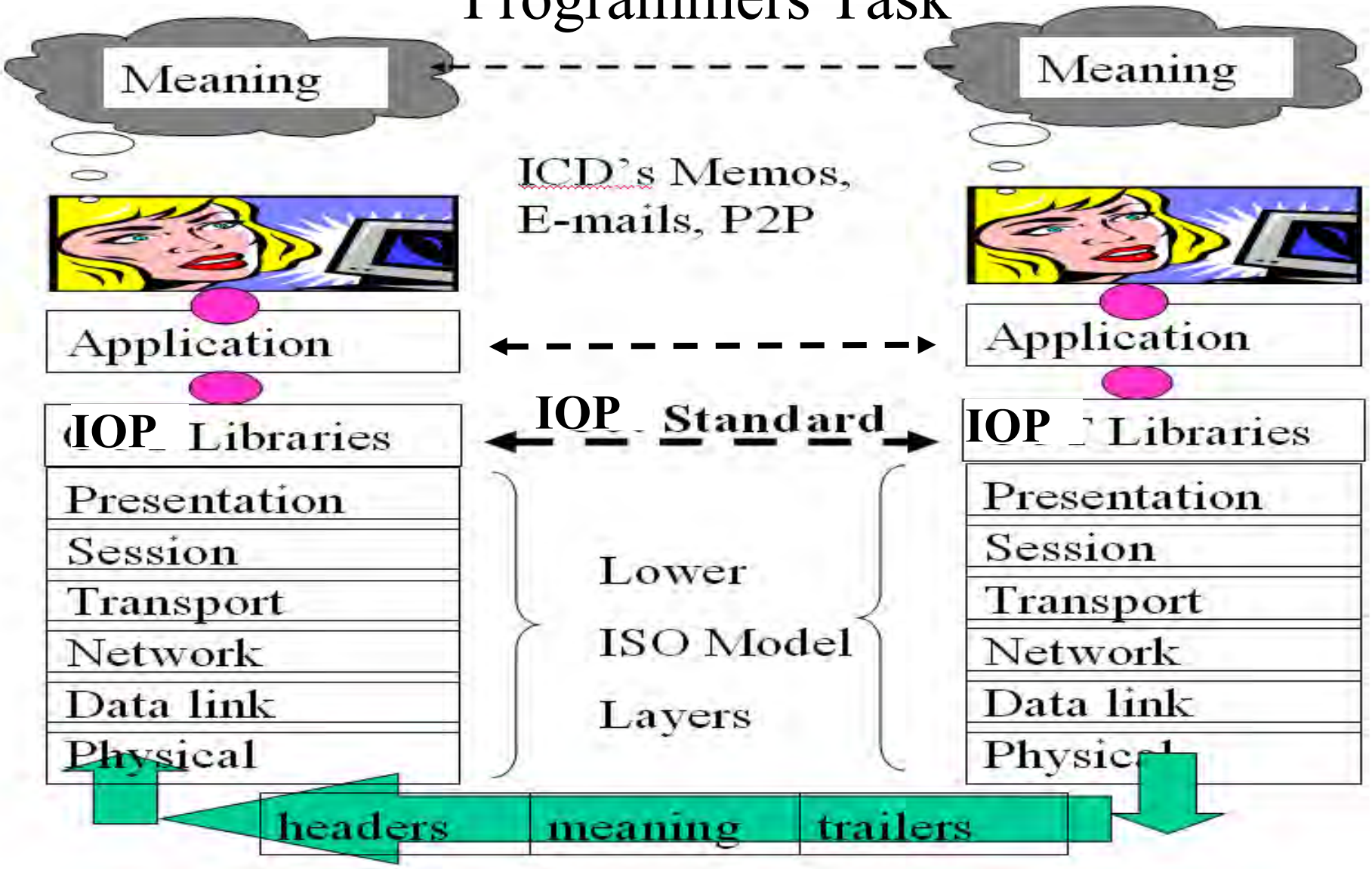
Interchangeable parts saves money

What Metrics are there to measure the Cost Effectiveness of standards Implementation?

- Not much in the literature
- Personal experience with SISO, SEDRIS, HLA, DIS, CoT, DTED, GPS, etc. etc.
- Some are good and save time and money
- Some are real dogs

How to analyze interoperability?

Step1. Reduce Interoperability to a Programmers Task



Step2: Analyze Interoperability Architecture

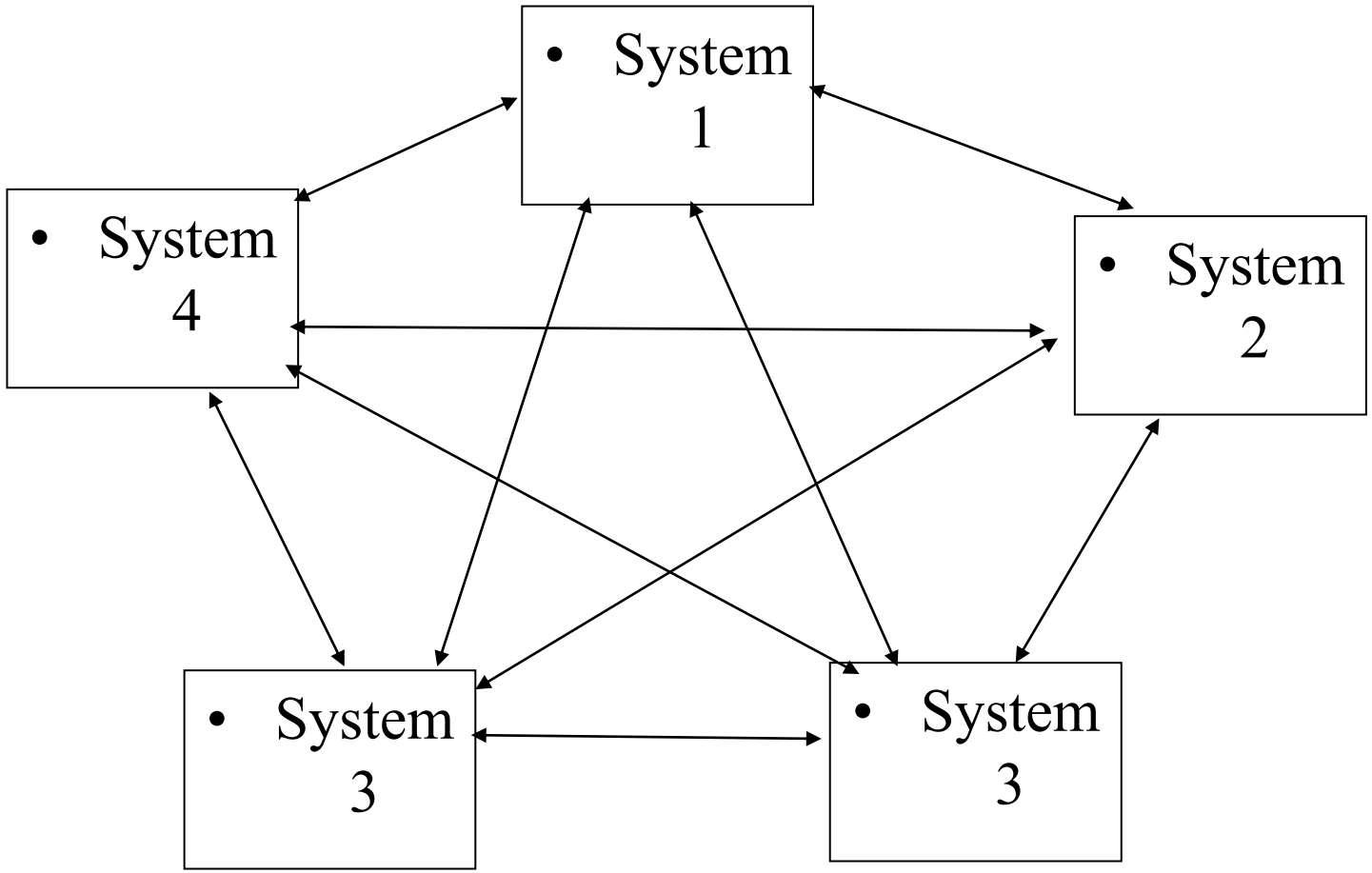


Fig. 2. – Five Interoperable Systems without standards
Requires (N-1)N interoperability tasks (N=5)

Step3: Reduce The interoperability Tasks by Introducing Standards

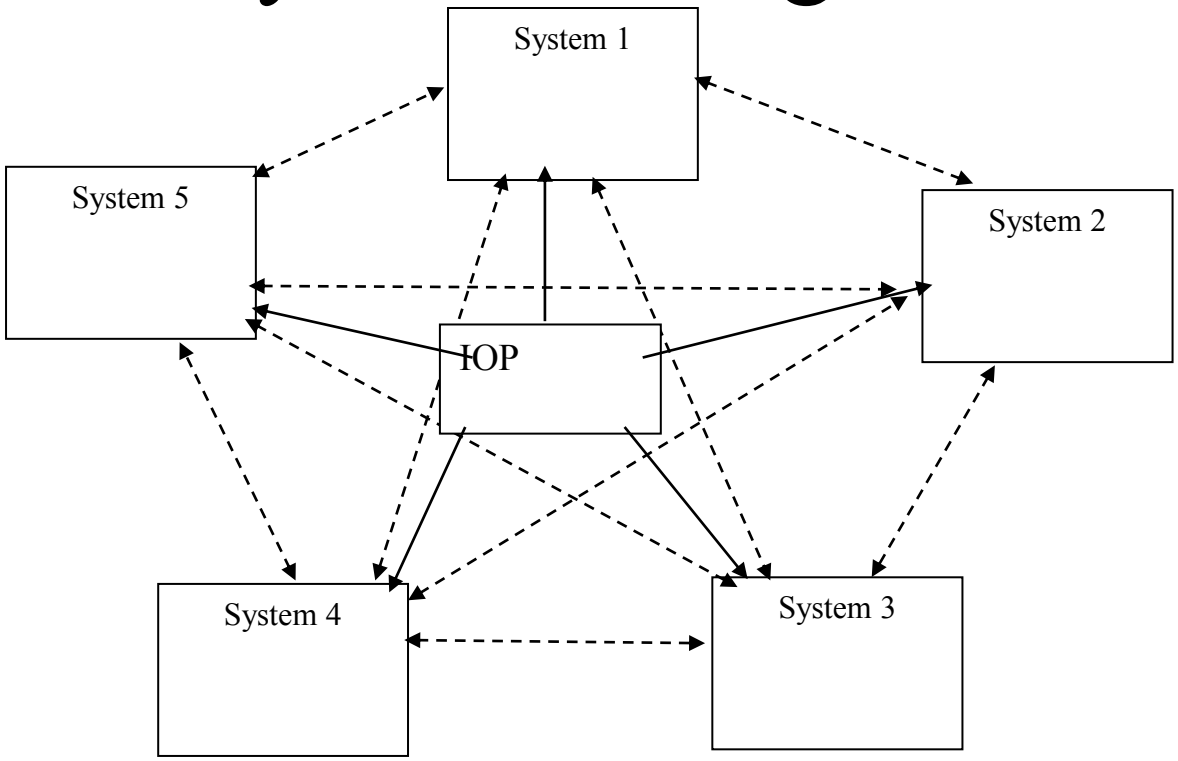


Fig 3 – Five Interoperable Systems types with standards

Reduces the number of tasks from N*(N-1) to N

Step 4: Calculate the value of introducing a standard

- (ISPV) Interoperability Standards Project Value
- (IoPT) Interoperability programming task
- (SER) Standards Effectiveness ratio
- (SCR) Standards Complexity ratio

Value of the Standard = Cost with no standard minus Cost with a standard

$$ISPV = N(N-1)*IoPT - \{ N*SCR + N*(N-1)*(1-SER)\}*IoPT.$$

Step5: Introduce a comparative metric Interface Standards Project Effectiveness (ISPE)

- (ISPVi) Value of the ideal standard with SER=SCR=1
- ISPVi= {N(N-1) - N}*IoPTs
- (ISPE) Standards Project Effectiveness
- ISPE = ISPV/ISPVi
- Which reduces to the basic metric equation:

$$ISPE = [(N-1)*SER - SCR]/(N-2)$$

Cost Reduction Assumption

A standard is ideal under two assumptions. These are:

- Standards Complexity Ratio SCR=1; i.e. the task cost of executing the interoperability task to the standard is equal to the cost of the point to point interoperability task.

- Standards Effectiveness Ratio SER=1 if there are no latent point to point tasks required in addition to the interface to the standard..

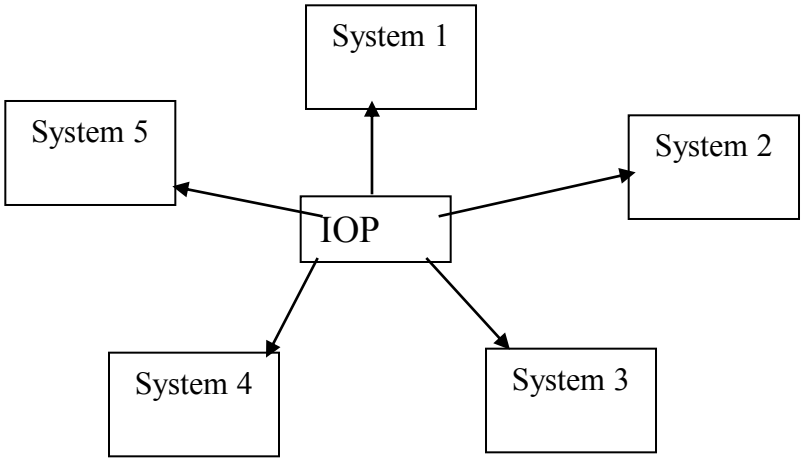


Fig 3 – Five Interoperable Systems types with standards for an ideal standard

Interoperability Standards Project Effectiveness (ISPE) ratio

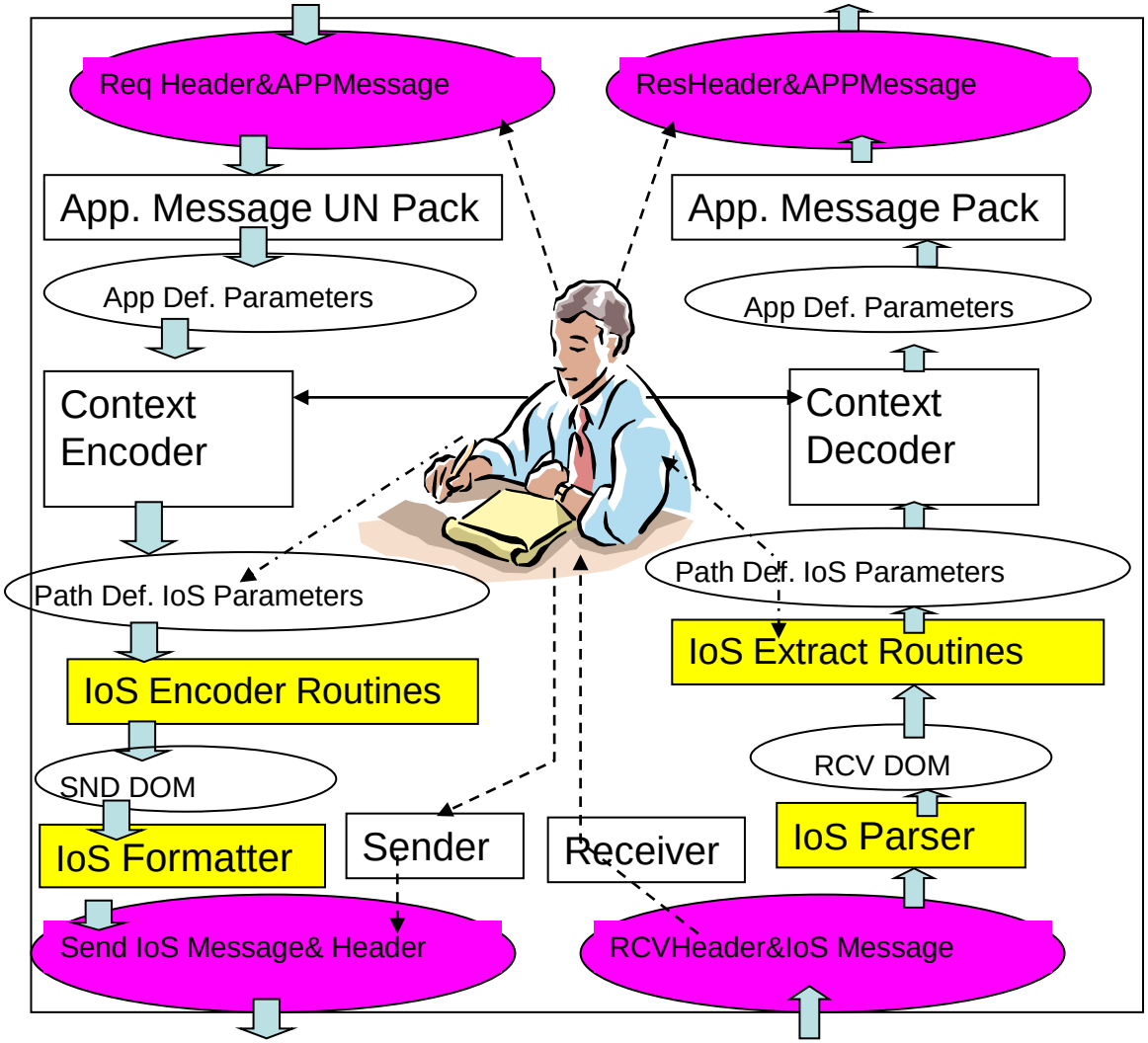
$$ISPE = [(N-1)*1 - 1]/(N-2) = 1$$

In this case we have an ideal standard.

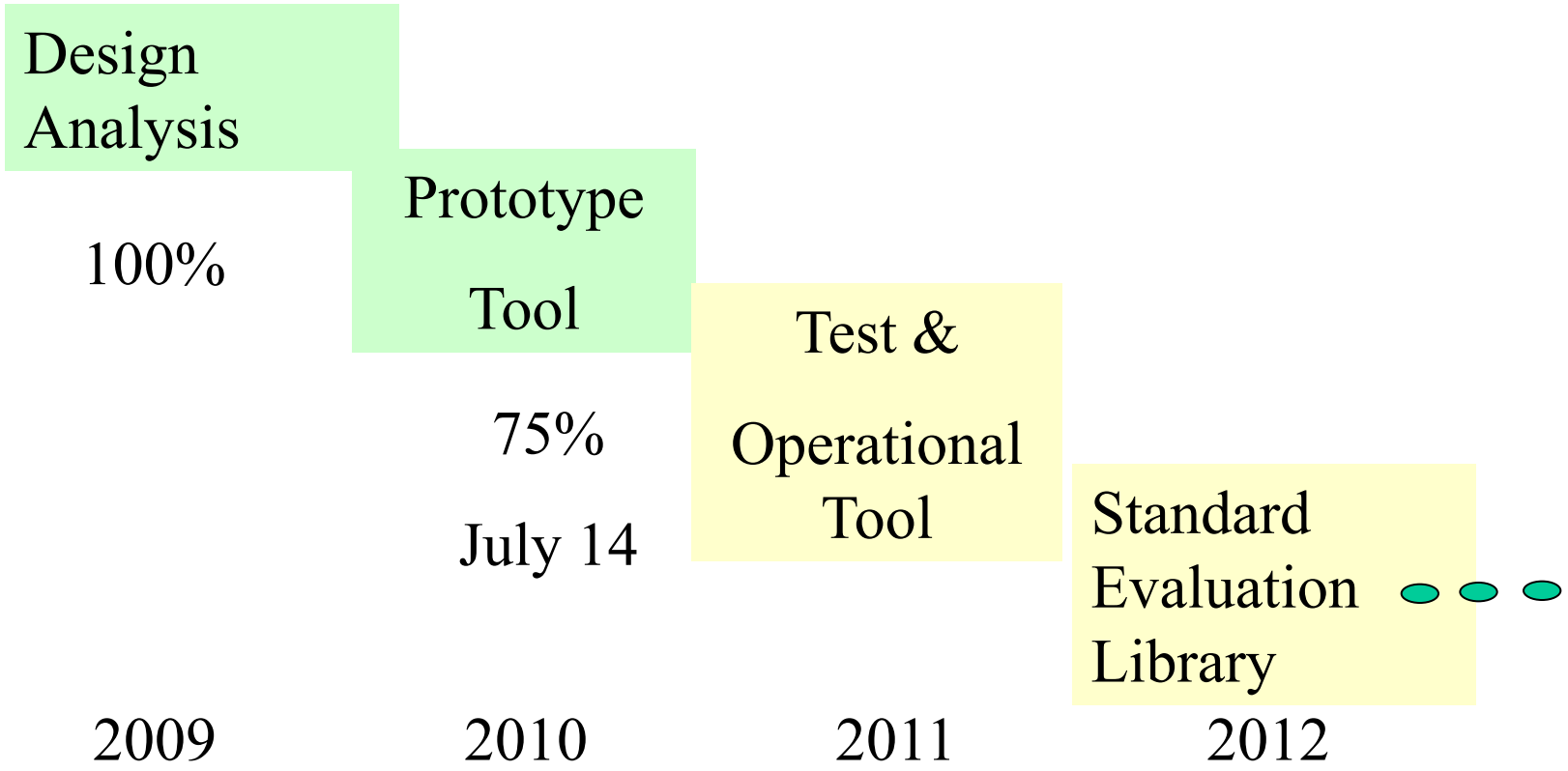
Step 6: To Evaluate Real Standards

- Estimate the cost of the interoperability Programmers task (IoPTs)
- Estimate the standards Effectiveness ratio (SER)
- Estimate the standards Complexity ratio (SCR)
- And do so as a function of standards characteristics

Define the Interoperability Programmers Task

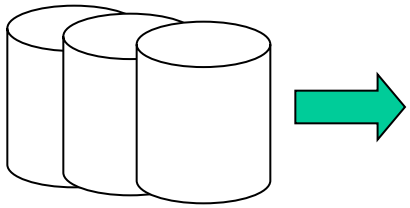


Work Plan

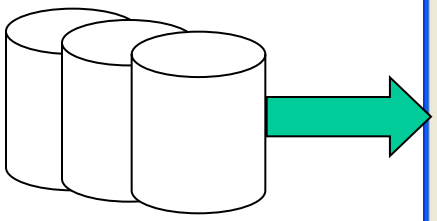

Design
Analysis
100%
Prototype
Tool
75%
July 14
Test &
Operational
Tool
Standard
Evaluation
Library
2009
2010
2011
2012

Prototype Tool

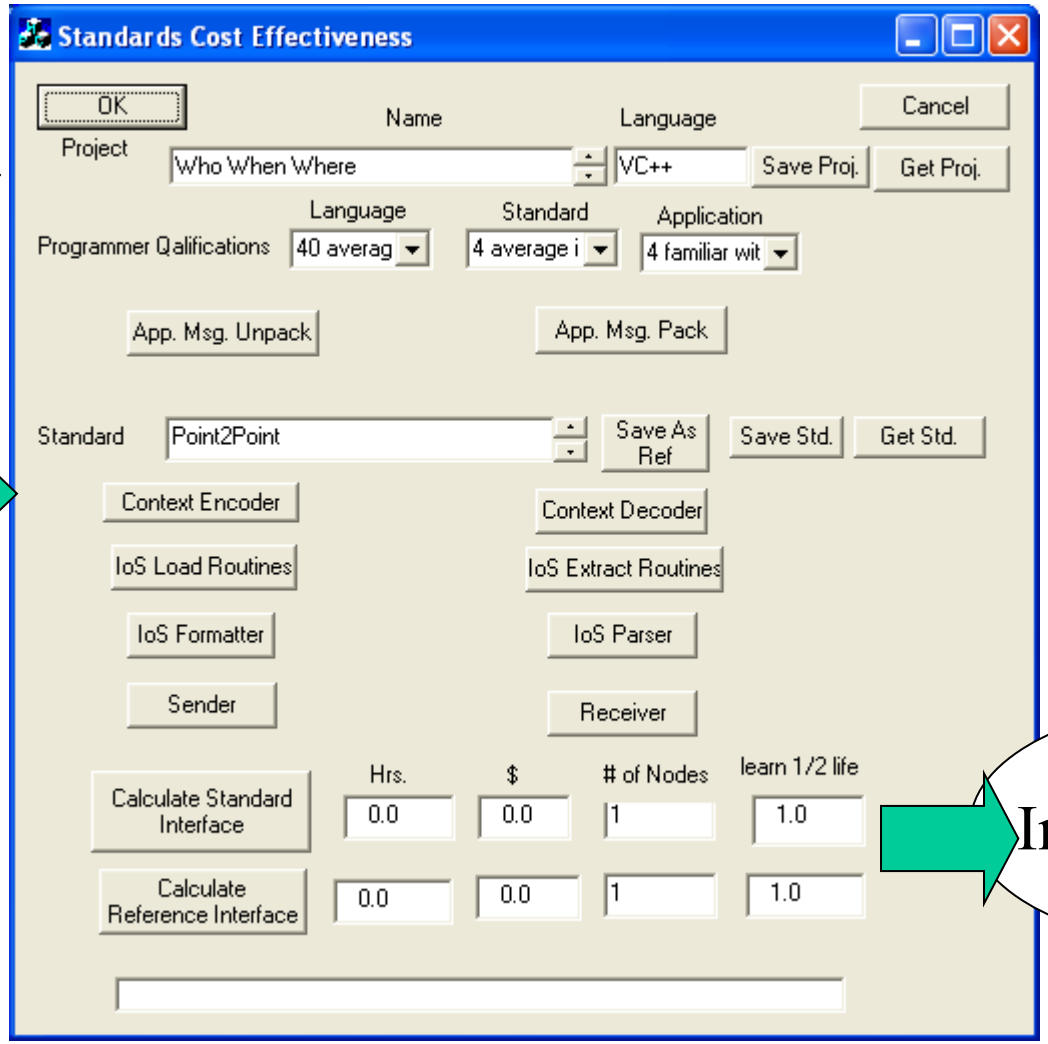
Main Control Dialog

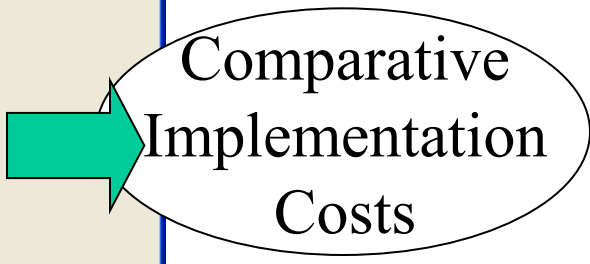


Project Files



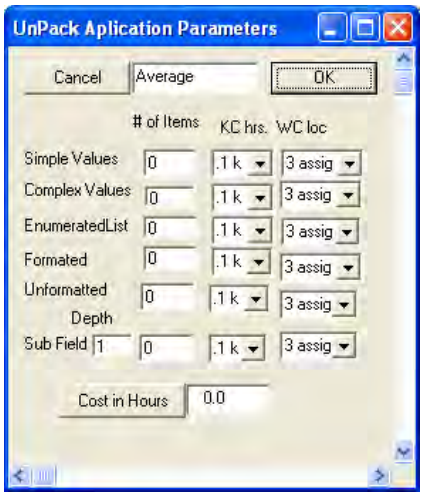
Standards Characteristics Files

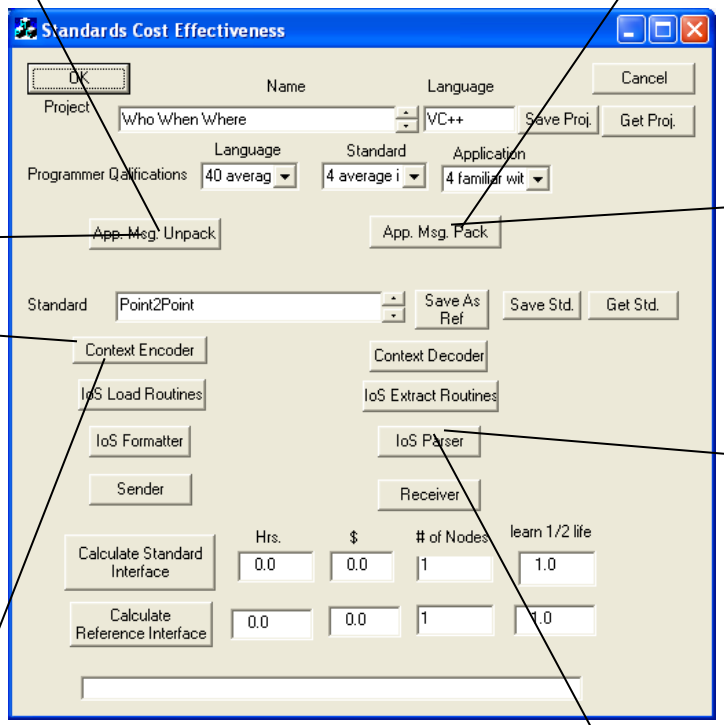


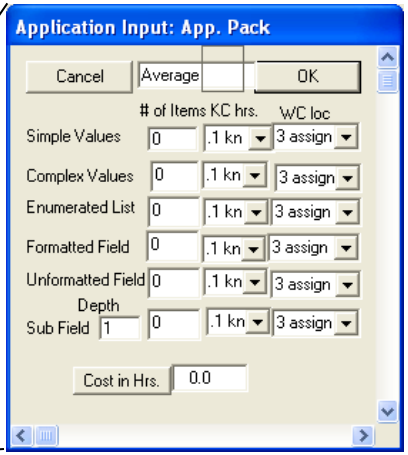


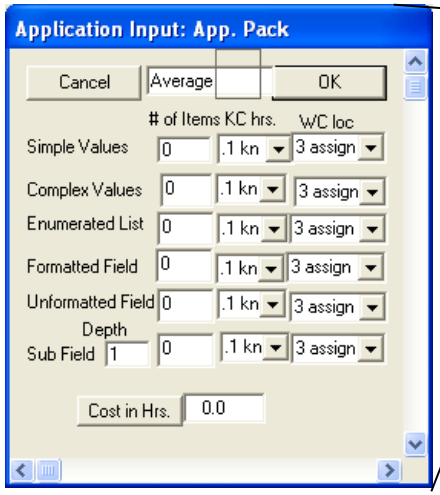
Prototype Tool

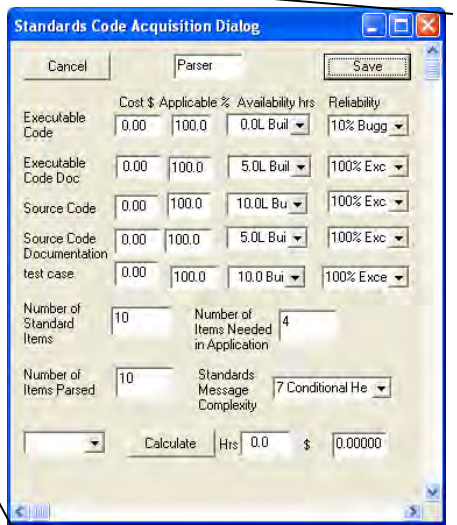
Standards Questionnaire Dialogs











Future Tasks

- 2010 –
  - Finalize and document the Standards Cost Effectiveness (SCE) prototype
- 2011-
  - Work with VMASC on “Standards in Modeling and Simulation: Next Ten Years” project Hon. Randy Forbes
  - SISO presentations and papers advertise capability
  - Test and work with Standards Program offices (CoT, Ucore,DIS,…

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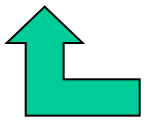
Backup Slides

Example Task Estimation Formula

IoPT = KDOMpF*F + WPARS + WEXTpF*F + KSF2LpF*N + WSF2LpF *N
+ KENCpF *N + WFOR + WENCpF*N + KL2SFpF*N +
WL2SFpF *N (18)

Where:

F		Number of fields or individual data items handled in the standard
KDOMpF	.1hrs	Knowledge to decode DOM location to IoS field name per field
WPARS	8hrs	Write Parser and message decoder
WEXTpF	1hr	Write extraction routine per field
KSF2LpF	1hr	Knowledge to understand IoS in terms of local parameter per field
WSF2LpF	2hr	Write IoS field to local parameter translator per field
KENCpF	.1hr	Knowledge to encode IoS Filed names into DOM locations per field
WFOR	8hrs	Write a formatter that builds a IoS message buffer
WENCpF	1hr	Write encoder from IoS Filed names into DOM locations per field
KL2SFpF	1hr	Knowledge to understand local variables in Ios terms per field
WL2SFpF	2hr	Write local variable to IoS symbol translators per field



I got these values by coding a test interface in C++ and keeping track of my time per coding task I got 726hrs

SCR
Complexity estimation considerations

- **IoS Message Parser and Extract Routines**
- **Context Decoder Information Requirements**
- **Context Encoder Information Requirements**
- **Programmer qualifications**

SCR
Complexity Estimation

By substituting the values estimated in this example for the 100field case used in section 4 we estimate a task cost

IoPTc = .5*F + 160 + 1*F + 2*F + 2 *F + .75 *F + 24 + 3*F + 1*F + 2 *F = 184 + 12.25*F = 1409 man hours

To be consistent we should add the same programmer qualification cost of 90hrs to get 1499hrs compared with 726hrs for the P2P case. The standard complexity ration is then

SCR = IOPT/IOPTi = 1499/726hrs = 2.06

Effectiveness Categories

- Incompleteness (M)
- Knowledge Ambiguities (O)
- Field Ambiguities (P)
- Undocumented Extensions (X)
- Subset extensions (SXS)

SER ={F/(F+M)}*{F/(F+O)}*{F/(F+P)}*{F/(F+X*SXS)}= 84.8% (16)

Example Test Case: F= for a 100 field standard, M=5, P=5,O=2 and all others zero.

Plugging into Standards Effectiveness Formulas for a 20 node 100 parameter interface

Cost Savings if we had an ideal standard

ISPVi= {N(N-1) - N}*IoPTs = (20*19-20)*726= 13,068hrs

Effectiveness of our test examle standard:

ISPE = [(N-1)*SER –SCR]/(N-2)

= [(20-1)*.84 –2.06]/(20-2) = 14/18 = 77%

Cost savings if we introduce our test example standard:

ISPV = ISPE*ISPVi = .77*13,068hr = 10164hrs

Cost to the project because the example standard is has deficiencies:

ISPV – ISPVi = 2904hrs or 1.5 man-years